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Waist Circumference and Waist-to-Hip Ratio in Adult Igbo's of Nigeria: Interrelation with Risk of Cardiovascular Disease

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Abstract: Waist circumference and waist to hip ratio are used as indicators of abdominal obesity in population studies. This study was carried out to predict if the Igbo ethnic groups are at a risk of cardiovascular disease. A total of 800 subjects were randomly selected, 400 males and 400 females between age range 20-65 years. A measuring tape was used to measure their waist and hip circumference to get its ratio. Their blood pressure and body mass index were also determined. The mean waist circumference, waist to hip ratio, blood pressure, body mass index and hip circumference were 84.27±8.13 cm, 0.88±0.05, 125/80±12.18/10.44 mmHg, 25±2.97 (kg/m^2) and 95.30±6.94 cm for males respectively and those of female subjects were 87.43±11.97 cm, 0.85±0.06, 122/79±11.95/10.98 mmHg, 27±4.88 (kg/m^2) and102.48±9.87 cm, respectively. Using z-test, there was a significant difference in their systolic pressure, body mass index and waist to hip ratio ($p<0.05$). Based on their age range the calculated parameters increased with an advancing age, especially from 40-65 years which means that this age ranges were at a higher risk than those between 20-39 years. In the study, 50% of the adult males had a waist to hip ratio greater than 0.95 cm which kept them at a higher risk than their female counterparts of which 21.87% had a waist to hip ratio greater than 0.85 cm. The result of this studies showed that the Igbo ethnic groups were pre-hypertensive and obese with an advancing age. This study signifies that they are at a risk of cardiovascular disease and need urgent medical attention.

Key words: Blood pressure, body mass index, hip circumference, waist-to-hip ratio, waist circumference

INTRODUCTION

Waist circumference and waist-to-hip ratio are widely used as an indicator of abdominal obesity in population studies. It is increasingly clear that waist-to-hip ratio is a better reflection of the accumulation of intra-abdominal or visceral fat depot, because of the postulated role of visceral fat depot in health risk disease. Behavioural factors associated with a high waist circumference and waist-to-hip ratio (e.g., high alcohol consumption, physical inactivity and smoking) were attributed to both relatively large waist and relatively narrow hips (Jacob *et al*., 2001; Barrett and Khaw, 2002; Bobak *et al*., 2003). Waist-to-hip ratio shows a graded and highly significant association with myocardial infarction risk world-wide. According to Charles and Laurie (2005), redefinition of obesity based on waist-to-hip ratio instead of Body Mass Index (BMI) increases the estimate of myocardial infarction attribution to obesity in most ethnic groups. People with higher waist circumference and waist-to-hip ratio tend to be at higher risk of cardiovascular diseases than people who carry more weight around their hips (Krisha, 2005). Seidell *et al*. (2001) also reported that large waist circumference in men and woman was associated significantly with low High density cholesterol (Low HDC-cholesterol. High waist circumference in females is associated with hyperlipidemia and cigarette smoking. High waist-to-hip ratio in men could be associated with environmental factors, nutritional factors, alcoholism and socio-economic factor (Gnasso *et al*., 1994). Waist circumference may be a better indicator of obesity related disease than Body Mass Index (BMI), especially among particular populations. The elderly, with less muscle mass, tend to have underestimated body mass index and body builders who are usually muscular could have a high body mass index. Certain ethnic groups are genetically predisposed to storing more fat in the abdomen, even at healthy weights. Having a history of alcoholism can cause central obesity syndrome (Hans *et al*., 1996). Waist-to-hip ratio are measures of obesity and are believed to be better predictors of coronary heart disease. Waist-to-hip ratio analyses the relationship between the waist and hip measurement to help you understand your body type and current health status. Most people store their fat in two distinct ways, often called "apple' and "pear" shape (Aronne, 2002). In spite of several reports on these important subjects on most populations of the world,

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Table 1: Summary of mean, standard deviation and error of systole, diastole, waist circumference, hip circumference, waist-to-hip ratio, weight, body mass index and height of sampled adult male and female subject

Parameter	No.	Range	Sum	Mean±SD	Variance
Systole (mmHg)	800	88.00	99032.00	123.79±12.18	148.401
Diastole (mmHg)	800	74.00	63473.00	79.34±10.71	114.743
Waist cir. (cm)	800	66.00	68678.00	85.85±10.35	107.048
Hip cir. (cm)	800	67.00	79114.00	98.89±9.25	85.728
WHR ratio	800	0.32	694.62	0.87±0.06	0.004
Weight (kg)	800	72.00	57941.00	72.43±11.51	132.538
Height (M)	800	0.47	1335.80	1.67±0.07	0.005
BMI ratio (Kg/m^2)	800	33.40	20789.61	25.99±4.08	16.707

Table 2: Summary of mean, standard deviation and error of systole, diastole, waist circumference, hip circumference, waist-hip ratio, weight, body mass index and height of sampled female subject

Parameters	No.	Range	Sum	Mean±SD	Variance
Systole (mmHg)	400	88.00	48831.00	122.08±11.95	142.884
Diastole (mmHg)	400	74.00	31654.00	79.13±10.98	120.653
Waist cir. (cm)	400	66.00	34969.00	87.42±11.97	143.232
Hip cir. (cm)	400	62.00	40993.00	102.48±9.88	97.584
WHR ratio	400	0.32	340.91	0.85±0.06	0.004
Weight (kg)	400	72.00	28088.00	70.22±12.68	160.924
Height (M)	400	0.35	650.34	1.63±0.06	0.003
BMI ratio (kg/m^2)	400	33.40	10640.51	26.60±4.88	23.856

Table 3: Summary of mean, standard deviation and error of systole, diastole, waist circumference, hip circumference, waist-hip ratio, weight, body mass index and height of sampled male subject

Parameter	No.	Range	Sum	Mean±SD	Variance
Systole (mmHg)	400	70.00	50201.00	125.50±12.18	148.41
Diastole (mmHg)	400	63.00	31819.00	79.54±10.44	109.03
Waist cir. (Cm)	400	38.00	33709.00	84.27±8.13	66.16
Hip cir. (CM)	400	34.00	38121.00	95.30±6.95	48.25
WHR ratio	400	0.28	353.71	0.88±0.06	0.003
Weight (kg)	400	46.00	29853.00	74.63±9.73	94.72
Height (m)	400	0.40	685.46	1.71±0.06	0.003
BMI ratio	400	20.67	10149.10	25.37±2.97	8.84

reports on Nigerians are however scarce with no report on the ethnic group under investigation hence the need for the present study.

MATERIALS AND METHODS

This study was carried out on 800 individuals in the Igbo ethnic group, comprising of 400 male adults and 400 female adults within the ages of 20-65 years residing in different Igbo states. The subjects were randomly selected based on the facts that they were all Igbo's, but the pregnant women were not included in this study and some physically challenged were excluded.

Waist circumference: This was measured by locating the hip bone and snugly (without compressing the skin) placing a tape measure around ones bare abdomen (Colby and Johnson, 2006).

Hip circumference: This was taken at the level of the two bony prominences felt in front of one's hips measured in centimeters (Onat *et al*., 1999). Directional measurement was in accordance with (Oladipo *et al*., 1999). All measurements were taken in centimeters and waist circumference was divided over the hip circumference to get its ratio. All measurements were taken with the subject standing upright (supine position) in a relaxed mood, facing forward and without compressing the abdomen. The data was subjected to statistical analysis using.

RESULTS

The values of the mean, standard deviation (SD) and standard error were calculated for waist circumference, hip circumference, waist to hip ratio, body mass index and blood pressure and the summary of the results for the parameters were presented in Table 1-10.

The general mean and standard deviation for both male and female subjects are shown in Table 1, result showed that the waist to hip ratio of the calculated parameters were 0.86±0.06 cm. The mean and standard deviation of waist circumference, hip circumference, waist-to-hip ratio and blood pressure of adult males were 84.2±8.13, 95.3±6.94, 0.88±0.05 cm and 125/79±12/10 mmHg respectively, and their female counterpart were 87.4±11.96, 102.4±9.87, 0.85±0.06 cm and 122/79±11/10 mmHg, respectively, which is shown in Table 2 and 3, observation showed that females had a higher waist and hip circumference. The maximum and minimum calculated parameters, general class intervals, individual class interval, mid-point and its frequency are shown in Table 4-6. The general mean at different age range are

Table 4: Summary of maximum and minimum values of systole, diastole, waist circumference, hip circumference, waist-hip ratio, weight, height and body mass index of all sampled individuals

Parameters	No.	Minimum	Maximum
Systole (mmHg)	800	90.00	178.00
Diastole (mmHg)	800	50.00	124.00
Waist cir. (cm)	800	65.00	131.00
Hip cir. (cm)	800	77.00	144.00
WHR ratio	800	0.71	1.03
Weight (kg)	800	44.00	116.00
Height (M)	800	1.50	1.92
BMI ratio (kg/m^2)	800	17.70	51.10

Table 5: Summary of class intervals, class mid-points and frequencies of all sampled individuals sorted out based on their age groups

Class interval (age group) (years)	Class mid-point	Frequency
20-29	24.5	455
30-39	34.5	140
40-49	44.5	92
50-59	54.5	95
60-69	64.5	18

Table 6: Summary of class intervals, class mid-points and frequencies of all sampled male and female subjects sorted out based on their age groups

Class interval (age group) (years)	Class mid-point	Frequency
Female		
20-29	24.5	215
30-39	34.5	62
40-49	44.5	59
50-59	54.5	59
60-69	64.5	5
Male		
20-29	24.5	240
30-39	34.5	78
40-49	44.5	33
50-59	54.5	36
60-69	64.5	13

shown in Table 7. The mean waist-to-hip ratio at different age range are shown in Table 8,the highest and lowest being 0.94 and 0.86 cm between age range 50-60 and 20-29 years, respectively in adult male while their female counterpart were 0.89 and 0.83 cm between age range 40-59 and 20-29 years, respectively. The mean systole, diastole, waist circumference, hip circumference and body mass index are shown in Fig. 1-6 represented with a bar chart, as individuals advanced in age.

Using z-test, values of the calculated parameters were used to compare if there existed a significant difference between both subjects, there was significant difference in the systole pressure, waist-to-hip ratio and body mass index therefore ($p<0.05$) shown in Table 10.

The percentage risk from a high waist-to-hip ratio in Table 9, showed that heart disease risk is higher with male and female with a waist-to-hip ratio greater than 0.95 and 0.85 cm with 50 and 21.87% risk respectively, as compared to those with waist-to-hip ratio below 0.95 and 0.85 cm with 17.6 and 3.85% risk, respectively.

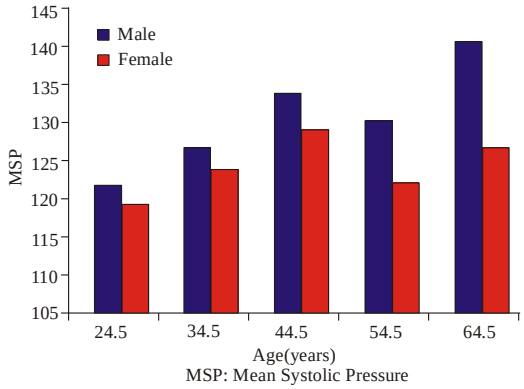

Fig. 1: Mean systolic pressures of sampled male and female subjects

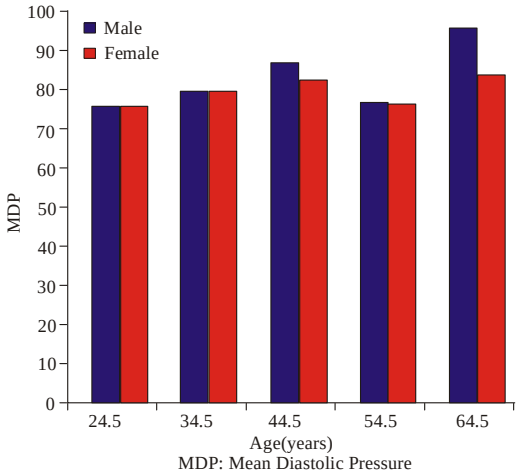

Fig. 2: Mean diastolic pressures of sampled male and female subjects

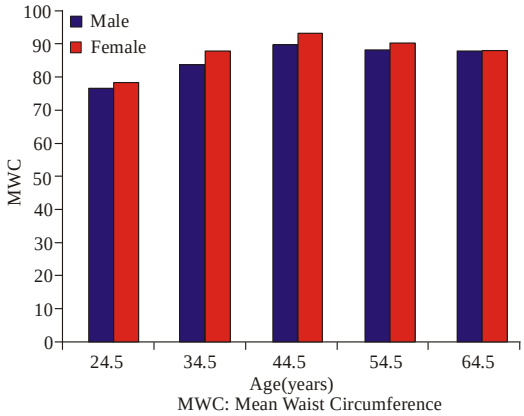

Fig. 3: Mean waist circumference of sampled male and female subjects

In Table 9 is seen that the percentage risk of cardiovascular and heart disease is higher with females with WHR above 0.85 and males with WHR above 0.95

Table 7: Summary of the mean values of systolic and diastolic pressures, waist-hip ratio, waist and hip circumferences and the body mass index of all sampled male and female subjects sorted out based on their age groups

Parameter	20-29	30-39	40-49	50-59	60-69
Female					
Systole	119.38	124.06	129.47	122.00	127.00
Diastole	77.5	81.21	83.58	77.78	85.00
Waist circ	82.10	90.82	97.27	93.05	91.40
Hip circ	98.54	107.16	109.36	104.88	104.40
WHR	0.83	0.85	0.89	0.89	0.87
BMI	24.26	28.01	30.96	29.20	27.16
Male					
Systole	121.95	127.25	134.85	130.94	141.61
Diastole	77,95	80.96	88.39	77.78	96.92
Waist circ	80.33	87.28	94.24	92.22	91.77
Hip circ	93.06	97.99	101.52	97.78	97.92
WHR	0.86	0.89	0.93	0.94	0.94
BMI	24.30	26.13	28.95	27.50	25.31

Table 8: Table represents percentage risk per age group

Age group (years)	No. of samples (n)	No. at health risk (r)	Risk (%)	Mean WHR
Female				
20-29	215	2	0.93	0.834
30-39	62	2	3.20	0.847
40-49	59	17	28.80	0.888
50-59	59	11	1.80	0.887
60-69	5	0	0	0.872
Male				
20-29	240	8	3.3	0.865
30-39	78	7	8.9	0.890
40-49	33	13	39.4	0.930
50-59	36	17	47.2	0.940
60-69	13	13	100	0.940

Table 9: Percentage risk categories and its relationship between sex, waist-to-hip ratio (WHR) and cardiovascular risk

Sex	WHR	Total no.	No at risk	Risk (%)
Female	>0.85	192	42	21.875
Female	<0.85	208	8	3.850
Male	>0.95	48	24	50.000
Male	<0.95	352	62	17.600

*: Risk (%) = [r/n] 100 * (Rost and Heck, 1987); Waist-to-hip ratio (Charles and Laurie, 2005)

Table 10: Using Z test of the parameters and comparing the mean values of the sampled male and female subjects

Parameter	Calculated 'z'	Tabulated 'z'	Level of significance	Significance
Systole	4.014	1.96	$p<0.05$	Significant difference
Diastole	0.544	1.96	$p>0.05$	No significant difference
Waist-hip ratio	7.544	1.96	$p<0.05$	Significant difference
Body mass index	3.396	1.96	$p<0.05$	Significant difference

at 21.875 and 50%, respectively, as compared to those with WHR below 0.85 for females and 0.95 for males with values 3.85 and 17.6%, respectively. From the results above, it is also shown that there is a higher risk of cardiovascular disease in males than in females regardless of waist-to-hip ratio

DISCUSSION

The study was directed towards predicting individuals at high risk of developing cardiovascular disease using the waist circumference, body mass index, waist-to-hip ratio and blood pressure which is widely used as indicator for health risk in population studies. The result of this study suggest that waist circumference, hip circumference and its ratio can be used to measure different aspects of body composition and fat distribution and have independent and opposite effects on determining cardiovascular disease risk factors. In previous study, it was observed that changes in body composition occurred with age, particularly in fat and skeletal muscle mass and its tissues (Jacob *et al*., 2001). This study was in accordance with this recent study where the waist circumference, hip circumference, body mass index and waist-to-hip ratio increased with an advancing age which was 82.10 cm, 98.54 cm, 24.26 (kg/m^2) and 0.83 cm, respectively being the lowest for the female adult between 20-29 years and from 40-49 years had 97.27 cm, 109.36 cm, 30.96 (kg/m^2) and 0.89 cm, respectively which was the highest while the male counterpart between 20-29 years had 80.33 cm, 93.06 cm, 24.03 (kg/m^2) and 0.86 cm, respectively which was the lowest and from 40-65

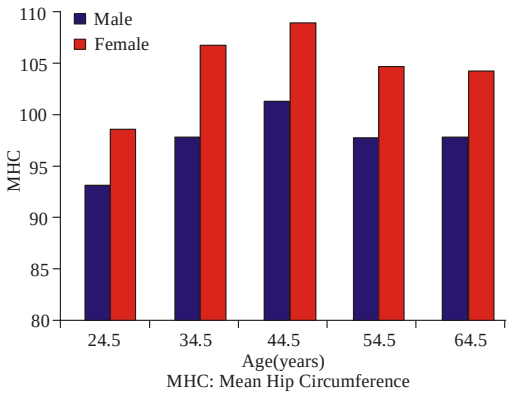

Fig. 4: Mean hip circumference of sampled male and female subjects

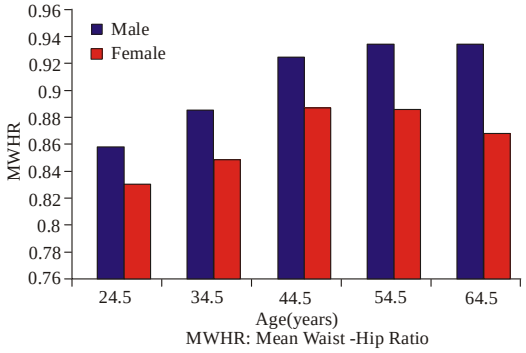

Fig. 5: Mean waist-hip ratio of sampled male and female subjects

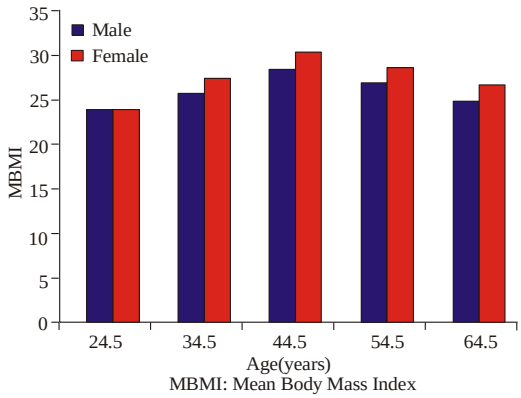

Fig. 6: Mean body mass index (BMI) ratio of sampled male and female subjects

had a varying range which were higher than the years backwards, thus judging from their blood pressure the individuals were pre-hypertensive with an an advancing age (Rost and Heck, 1987). Therefore, waist circumference and waist-to-hip ratio is now the preferred measure in the context of population studies. Men with waist-to hip ratio (WHR) greater than 0.95 are considered to be at high risk of obesity and heart risk while women with waist-to hip ratio greater than 0.85 are also considered to be associated with heart risk problems (Charles and Laurie, 2005). This was also in accordance with this present study which showed that 50% adult male had waist-to-hip ratio greater than 0.95 and above, while 21.87% adult female had waist-to-ratio of 0.85 and above and are predisposed to obesity, diabetes, hypertension and other health risk factors. Thus, the adult males were at a higher risk of cardiovascular disease than adult females regardless of their waist-to-hip ratio. Waist circumference, body mass index, waist–to hip ratio and blood pressure was found to increase with an advancing age. There was significant difference in the systole pressure, waist-to-hip ratio and body mass index of the sampled male and female subjects ($p<0.05$). The general mean and standard deviation of waist circumference, hip circumference, waist-to-hip ratio and blood pressure of adult males were 84.2±8.13, 95.3±6.94, 0.88±0.05 cm and 125/79±12/10 mmHg respectively, and their female counterpart were 87.4±11.96, 102.4±9.87, 0.85±0.06 cm and 122/79±11/10 mmHg respectively, but in female during their puberty stage, their Hip circumference increased more than the male counterparts, this accounts for low waist-to hip ratio in females. Comparison between the two sampled individual investigations showed that males had higher waist- to- hip ratio than the females. This could be as a result of environmental factor, nutritional factors, alcoholism and socio-economical factors as reported by earlier researchers (Yusuf and Ounpun, 2005). With the knowledge of waist to hip ratio, individual can be advised to maintain or adjust the degree of body fatness, abdominal fats, diet and over weight to the limits, associated with optimal health and minimal heart risk, otherwise increase in waist-to-hip ratio could lead to obesity, over weight and subject individuals to high risk of cardiovascular related disease, if not properly managed.

CONCLUSION

This study has established the presence of sexual dimorphism in the waist circumference, hip circumference waist-to-hip ratio of adult male and female of the Igbo ethnic groups of Nigeria. It has also established that a large percentage of these populations are at risk of obesity and related disease and hence need urgent intervention from medical experts. The results of this study are expected to be of importance to nutritionists, clinicians, anthropologists and forensic scientists and serve as the basis for comparison for future studies on other Nigerian ethnic groups.

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